#0060-2

E73 10764
CR-132206

CENTER FOR RESEARCH, INC.
UNIVERSITY OF KANSAS
ERTS DETAILED IMAGE INTERPRETATION REPORT

CRINC DIIR No. 2262-2
Date Prepared 24 Jan 73

Subject:
Area Measurement of Land Use Categories in Finney County, Kansas

Subject Geographic Coordinates 38-05N/100-45W
NASA Test Site No. 76

NASA Image Descriptors:
Mensuration

Report Summary:

Errors inherent in measurement of surface areas from ERTS-1 MSS imagery are identified as to source. Empirical measurement data are developed and considered, and the identified surface area measurement error is shown to increase as area decreases. These data lead to the conclusion that serious area measurement error may be anticipated on on ERTS-1 MSS imagery for single areas less than 10 mi^2.

Imagery References

CRINC Image No.	NASA Image ID Block	Subject Image Coordinates X	Y	Cloud Cover	Image Quality
MP00330	E-1024016511-5	(9.5) 34	56	0	Good

Map References:

USGS NJ14-4, NJ14-7, scale 1:250,000

Digital Data Used: Yes ___ No x

Image Analyst: Jerry C. Coiner, Donald L. Williams

Principal Investigator: Robert M. Haralick

NASA Contract No. NAS 5-21822 MMC #060-II

User ID No. U317

REPORT

An integral part of land use mapping is the measurement of areas assigned to each land use category. Measurements of this type were performed during preparation of a land use map of Finney County, Kansas (CRINC DIIR 2264-3). This report discusses methods of mensuration used with ERTS-1 imagery to compile area data on land use categories.

The following procedure was used. 1) A 9.5" MSS band 5 positive transparency was enlarged using 3.16X Polaroid prints. 2) These enlarged positive prints were then mosaiced to form a base graphic to a) display the areas of different land use and b) to measure these areas. 3) The areas were then measured using a Hewlett Packard HP9200B calculator digitizer. 4) These measurements then formed the basis for land use tables accompanying the land use map.

Prior to any assessment of the validity of how accurately the land use map reflects the actual land use in Finney County, an assessment of the accuracy of the area measurements must be made. The accuracy of these measurements is controlled by the following factors:

a) minimum resolvable area
b) systems distortion
c) measurement device error
d) photographic reproduction error, and
e) operator error

The instantaneous field of view of the ERTS-1 multispectral scanner subsystem is .086mr. This produces a resolution cell of approximately 80m. No boundary may be located more precisely than $\pm$ one resolution cell. For linear measurements, each end of the line is controlled by this limitation giving a total line length error of from -160 to +160m.

Systems distortions result from the fact that the scanner is composed of multiple elements which, although of excellent quality, are not perfectly aligned and do not operate with perfect constancy. The curvature of the earth and changes in scanner to ground distance introduce slight scale variation and locational displacements. None of these factors are large, but each contributes some small error term component.

Measurement device error results from the finite limitation of any device to record difference. In this case, theHP 9200B digitizer cannot delimit points less than .01" apart. Therefore, at a scale of 1:1,000,000, no two points less that 254m apart can be determined. Mensuration in this problem was actually accomplished at a scale of

1:316,000, which reduced the minimum required separation to 80m per point. This measurement error is of the same magnitude as the dimensions of one resolution cell. Therefore, measurement device error falls within the inherent limitation of system's resolution.

Some error is indicated by the optical processes and emulsion stability of the photographic products used in this study. The exact magnitude of this error was not functionally determined, but was thought to be less than the 80 meter system's resolution limitation.

Operator errors occur in three stages of the measurement process. The first introduction of error occurs in the mosaicing process where the six 4x5" Polaroid enlargements were assembled. The second source of error was in drawing the boundaries of Finney County and the land use subdivisions. The third was in the physical process of taking the area measurements. These errors were minimized by having two interpreters concur in each step. Multiple readings for each area measurement were taken to reduce the operator error until it converged on the known measurement device error.

The county area measured from the ERTS-1 image differs from the actual county area of 1308 mi^2 by 8 mi^2 or 0.6 percent. Measured and actual areas for several parts of the county are listed in Table 1. The associated error terms are graphed in Figure 1. A power function was fitted for these points as percent error against size of area. The resulting equation

$$Y = 9.204X^{-0.382}$$

yields a correlation of $r = -.84$. The function demonstrates that as area increases, percent error decreases asymptotically. The only serious deviations from the function occur with single areas of less than 10 mi^2, confirming the hypothesis that measurement of areas of less than 10 mi^2 on ERTS-1 MSS images must remain suspect. This analysis has indicated, however, that the error may be Gaussian. Therefore, measurement of large numbers of small areas may be summarized, and the error of the summation may be expected to behave as the error of a single area equal to the summation.

TABLE 1

Measured and actual areas for county segments of different sizes. Error terms in square miles and percentage of measured area are included in columns 3 and 4.

1	2	3	4
Actual Area (mi^2)	Measured Area (mi^2)	Maximum Difference (mi^2)	Percent Error on Actual Area
1	0.95 ± 0.07	0.12	12.0
1	1.004 ± 0.029	0.033	3.3
3	3.44 ± 0.02	0.46	15.3
3.25	3.52 ± 0.07	0.34	10.5
9.5	9.63 ± 0.07	0.20	2.1
156	155 ± 0.6	1.6	1.0
1308	1361 ± 1	9	0.7

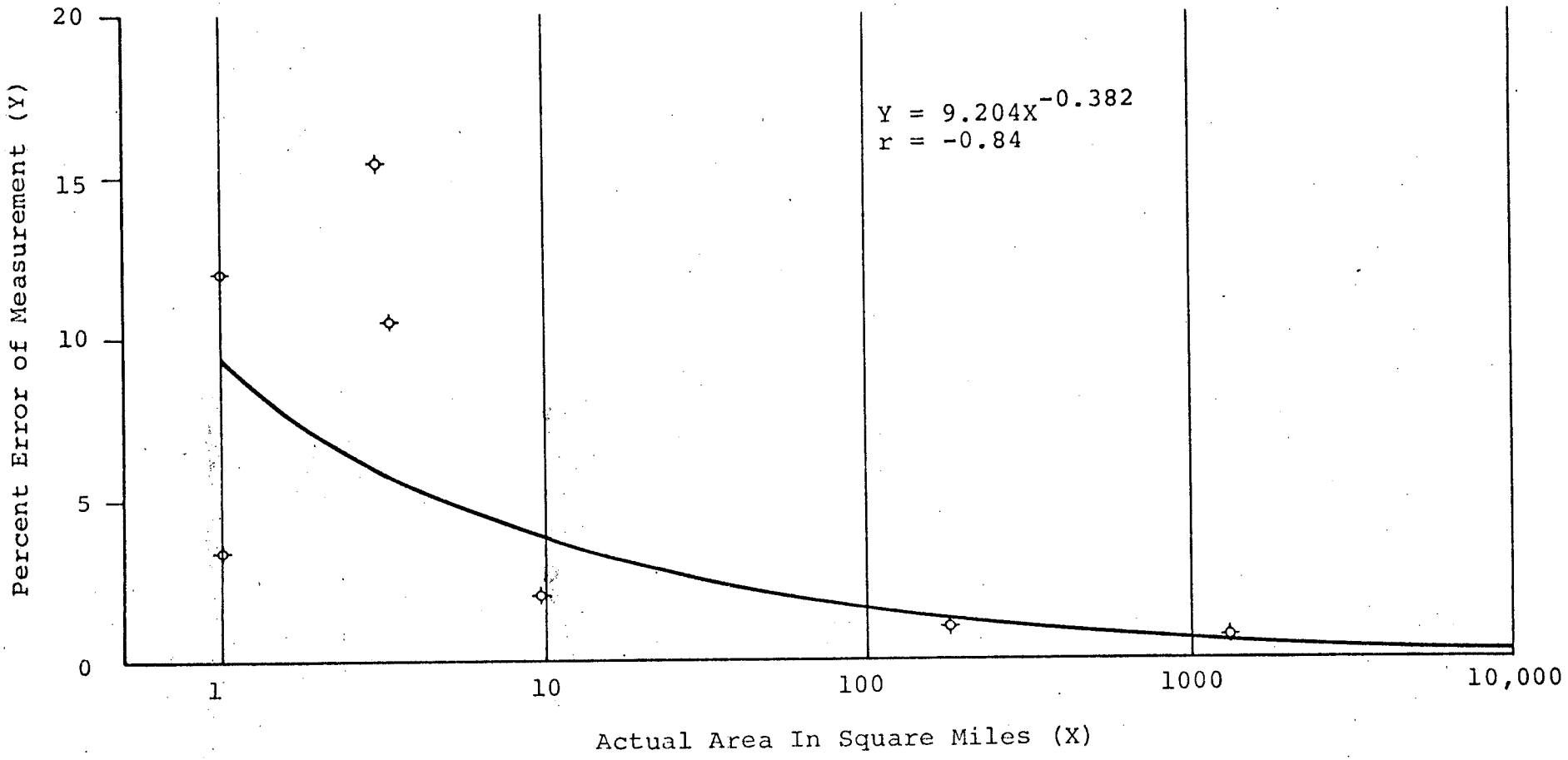

Figure 1. Relationship of measured to actual area expressed as percent error from actual area.